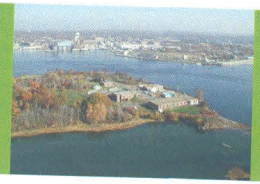
# City of Portsmouth Wastewater Division

## Wastewater Master Plan – Phase 2 Initial Piloting

# Piloting Technical Memorandum Review Meeting

December 18, 2012

# Presentation Outline



1. Introductions
2. Wastewater Master Plan Piloting
3. Revised Design Flow and Loads
4. Open Discussion
5. Additional Discussion Items

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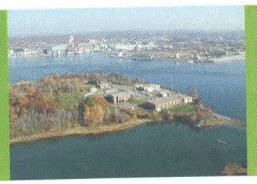
# Wastewater Master Plan (WWMP)



- June 2010 City completed WWMP/LTCP Update
  - Recommended transfer of sanitary flow to Pease and CSO treatment at PI
- WWMP Recommendations Rejected
  - Timeline unacceptable
  - Anti-degradation at Pease Outfall
- Value Engineering Looks at Filter Building for Secondary Treatment at PI
  - Approach recommended by regulators
- October 2010 Secondary Retrofit Feasibility Evaluation Completed
  - High rate technologies recommended to meet Secondary Treatment
  - BAF, MBR, MBBR and settling
- November 2010 Final Supplement to WWMP/LTCP Update Submitted
  - Revised implementation timeline
  - Recommends piloting at PI of high rate technologies and BioMag

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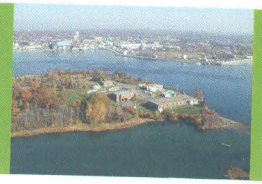
# Wastewater Master Plan (WWMP) (Continued)



- September 2011 Phase I Pilot Engineering Evaluation
  - Recommended on-site pilot of BAF, CAS with BioMag and MBBR and DAF

- September 2012 Phase II Initial Piloting
  - Performed Nov 2011-Aug 2012
  - Secondary treatment pilot operation
  - July 2012 – Receive written notice of TN<8 permit requirement
  - Nitrogen treatment pilot operation
  - Recommended 6.1 MGD BAF for

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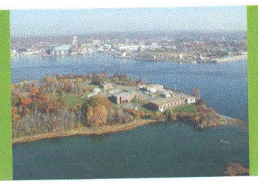
# Meeting Consent Decree Requirements



| | |
|---|---|
| • RFQ for Prelim and Final Design | SOQ Due Jan 17 |
| • Preliminary Design | Feb - June 2013 |
| • Begin Final Design | July 1, 2013 |
| • Complete Final Design | August 31, 2014 |
| • Begin Construction | March 1, 2015 |
| • Complete Construction | March 1, 2017 |
| • Achieve Compliance | May 1, 2017 |

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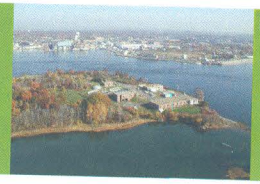
# Goals of Today's Meeting



- Review Pilot Data, Evaluation and Recommendations
- Focus on Wastewater Flows and Loads
- Ask and Answer Questions
- Time Permitting
  - Ongoing City Efforts
  - Other Regulatory Concerns

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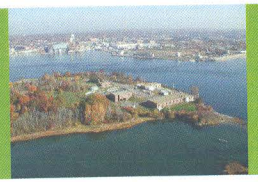
# Wastewater Master Plan Piloting



- Piloting Purpose & Approach
- Pilot System Components and Layout
- Pilot Data Analysis
- Secondary Process Resizing and Comparison
- Non-Monetary Evaluation Factors
- Piloting Technical Memorandum Recommendations and Assumptions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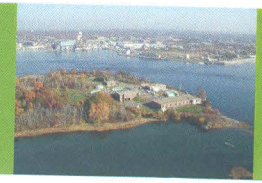
# Piloting Purpose & Approach



## Purpose:

1. Evaluate Ability of 3 Technologies to Meet Secondary NPDES Permit Limits
2. Evaluate Ability of 3 Technologies to Meet TN of 8 mg/l and 3 mg/l
3. Complete a Wastewater Characterization Program
4. Establish Design Flows for the Upgraded WWTF
5. Confirm Manufacturer/Vendor Sizing Criteria and Space Requirements to Provide Secondary Treatment/Nitrogen Removal Using Each Technology
6. Define Technology Performance Under Varying Flow Conditions
7. Identify Operational And Maintenance Factors Specific to Each Technology
8. Identify Technology That Will Best Meet Current and Future Regulatory Requirements

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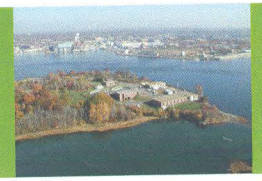
# Piloting Purpose & Approach



## Approach:

- Construct/Obtain Pilot Units for 3 Technologies:
  - ✓ Biological Aerated Filter (BAF)
  - ✓ Conventional Activated Sludge with BioMag (CASB)
  - ✓ Moving Bed Bioreactor (MBBR) and Dissolved Air Flotation (DAF)
- Initially Configure Pilot Units for Secondary Treatment
- Reconfigure Pilot Units for Nitrogen Removal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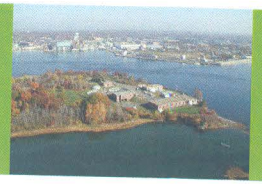
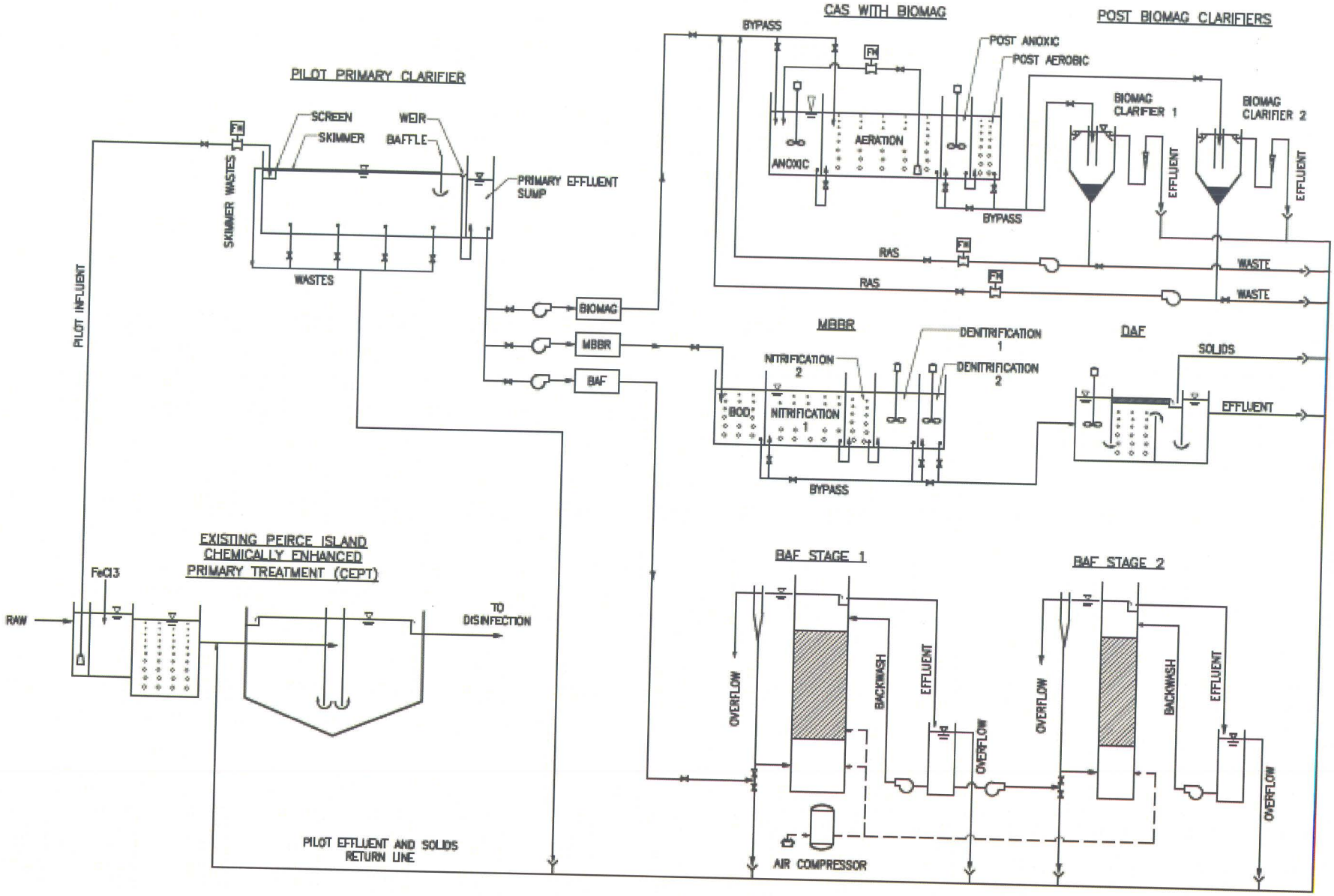
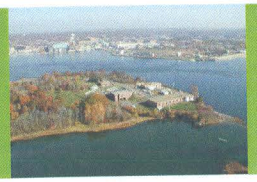
# Pilot System Components & Layout





# Pilot System Components & Layout



Pilot Primary Clarifier

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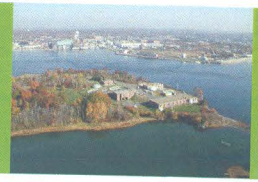
# Pilot System Components & Layout




**BAF Pilot Columns**

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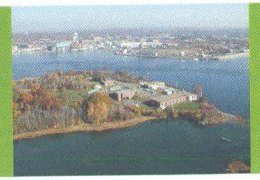
# Pilot System Components & Layout



Top of First Stage BAF

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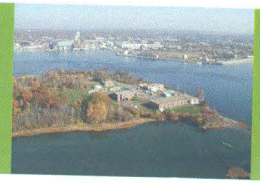
# Pilot System Components & Layout



CASB Aerobic Reactor

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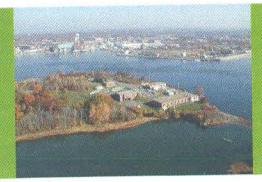
# Pilot System Components & Layout



CASB Clarifier

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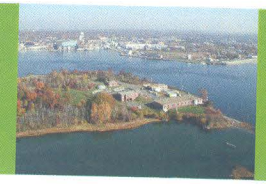
# Pilot System Components & Layout



CASB Aerobic Reactor

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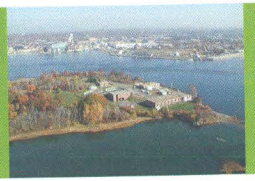
# Pilot System Components & Layout




MBBR DAF Clarifier

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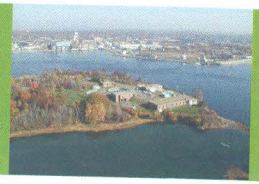
# Pilot System Components & Layout



February Sunset Over the Pilot Plant

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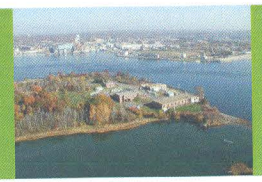
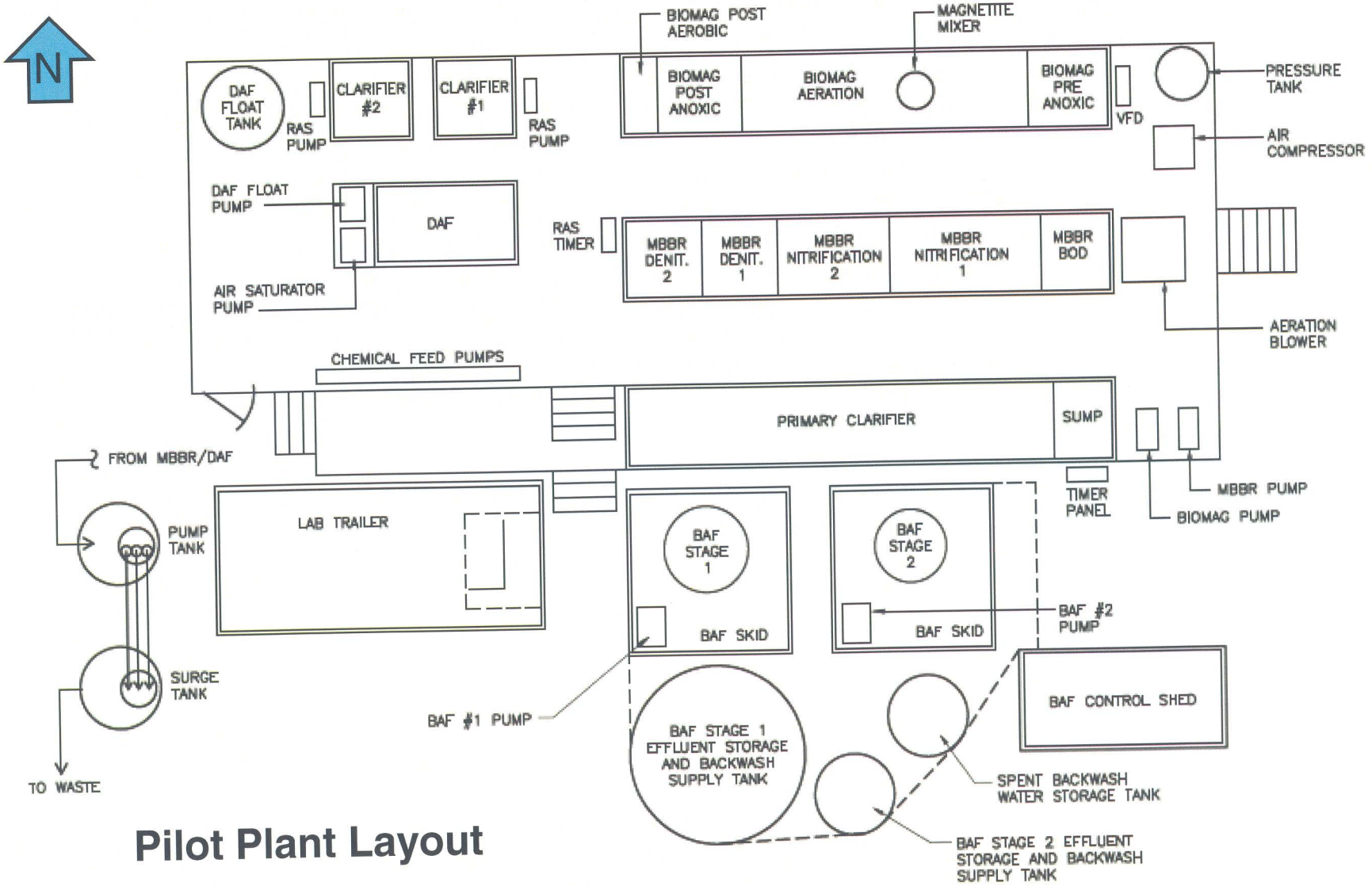
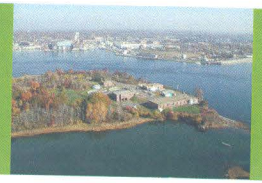
# Pilot System Components & Layout






## Pilot Plant Layout

# Pilot Data Analysis



## Analysis of Pilot Data Focused on 3 Areas:

- Ability to Meet Effluent Goals
  - ✓ Secondary Treatment
  - ✓ Total Nitrogen of 8 mg/l and 3 mg/l
- Vendor Loading Rate Validation
- Hydraulic Stress Test Performance

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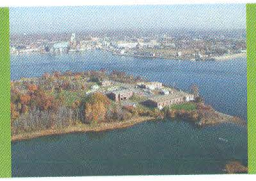
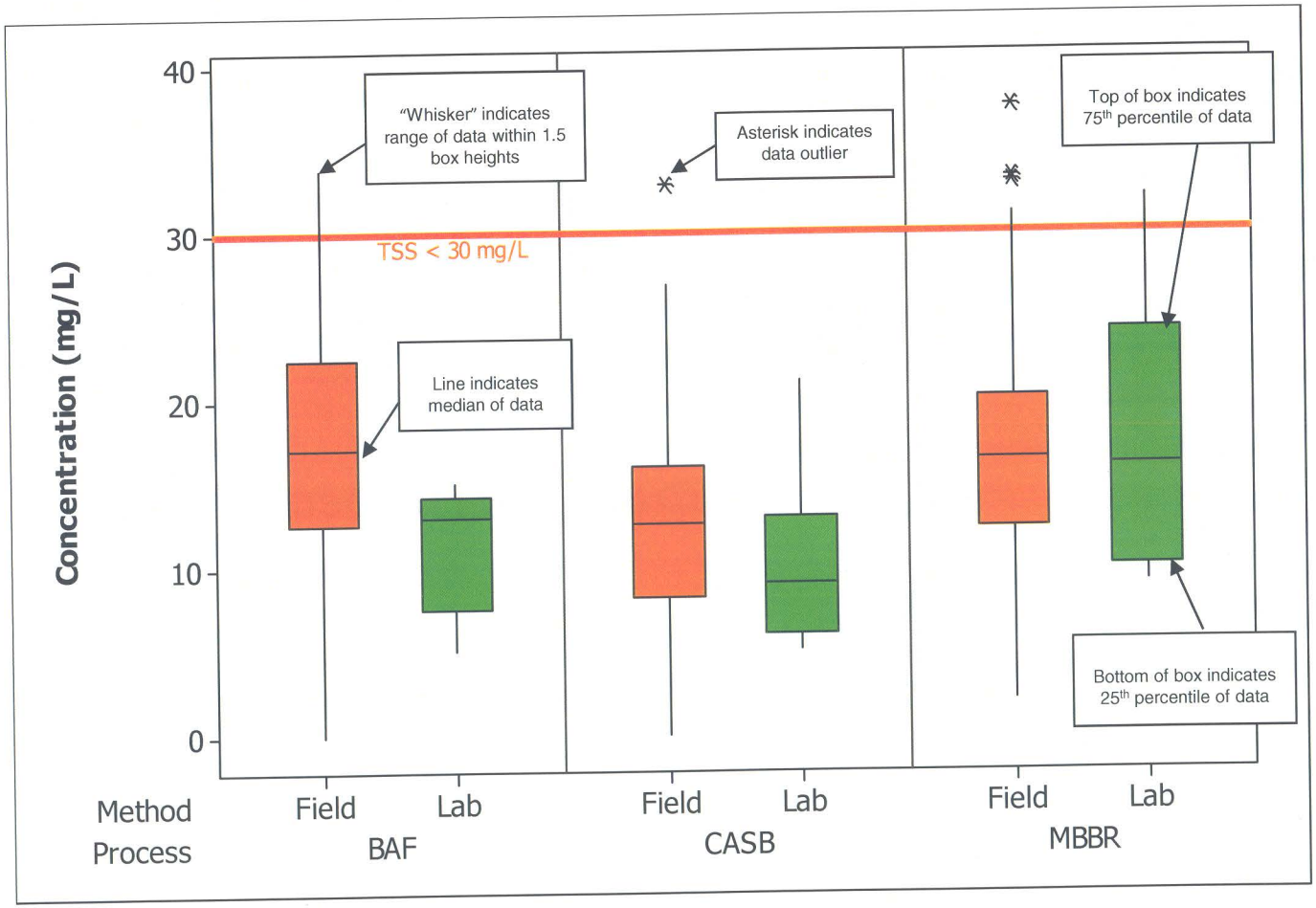
# Pilot Data Analysis



## TSS:

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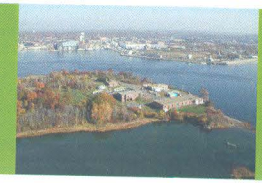
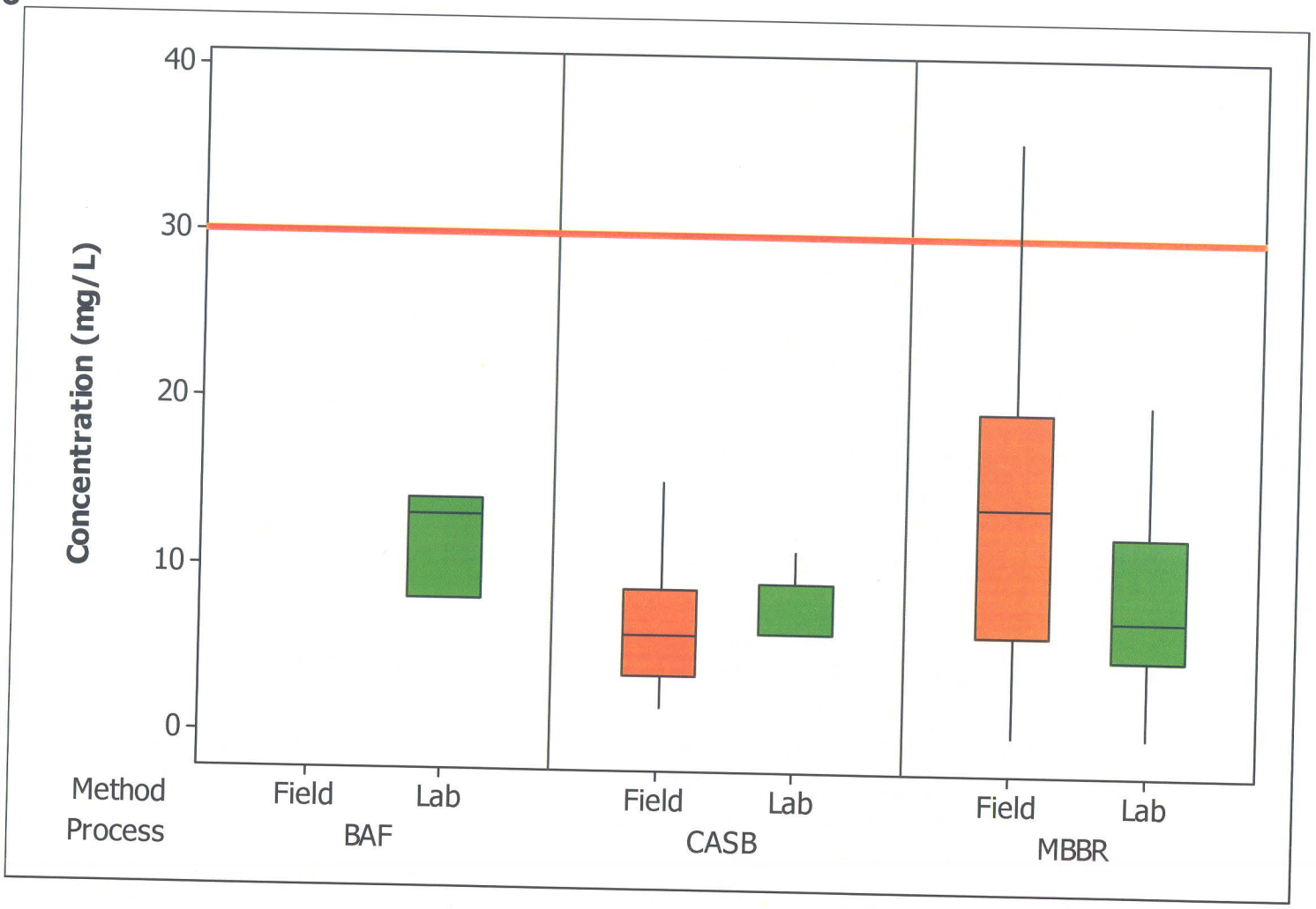
# Pilot Data Analysis



## $BOD_5$:

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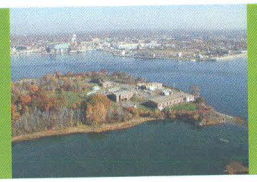
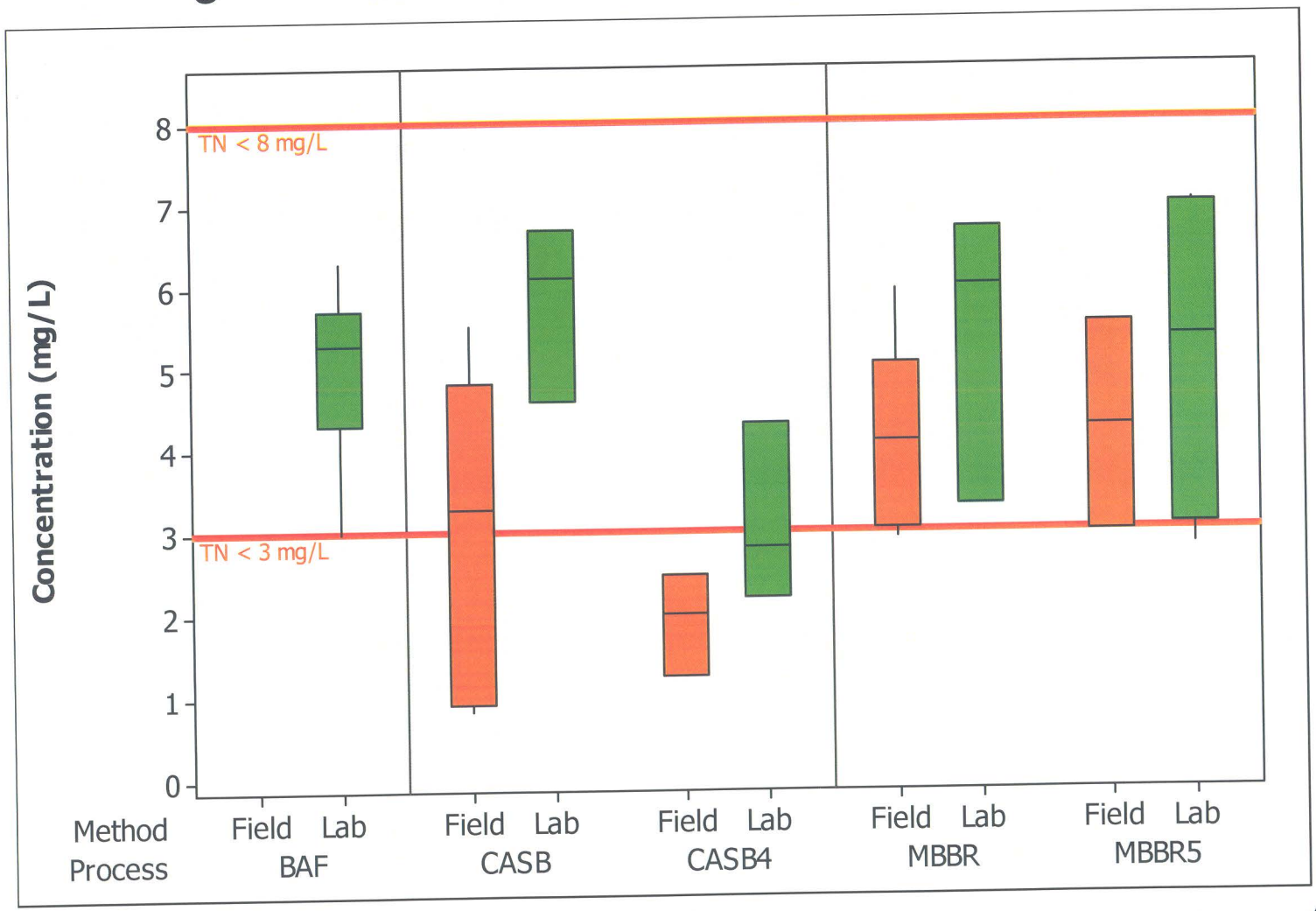
# Pilot Data Analysis



## Total Nitrogen:

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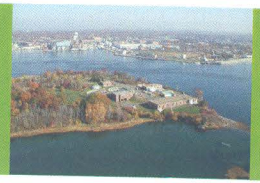
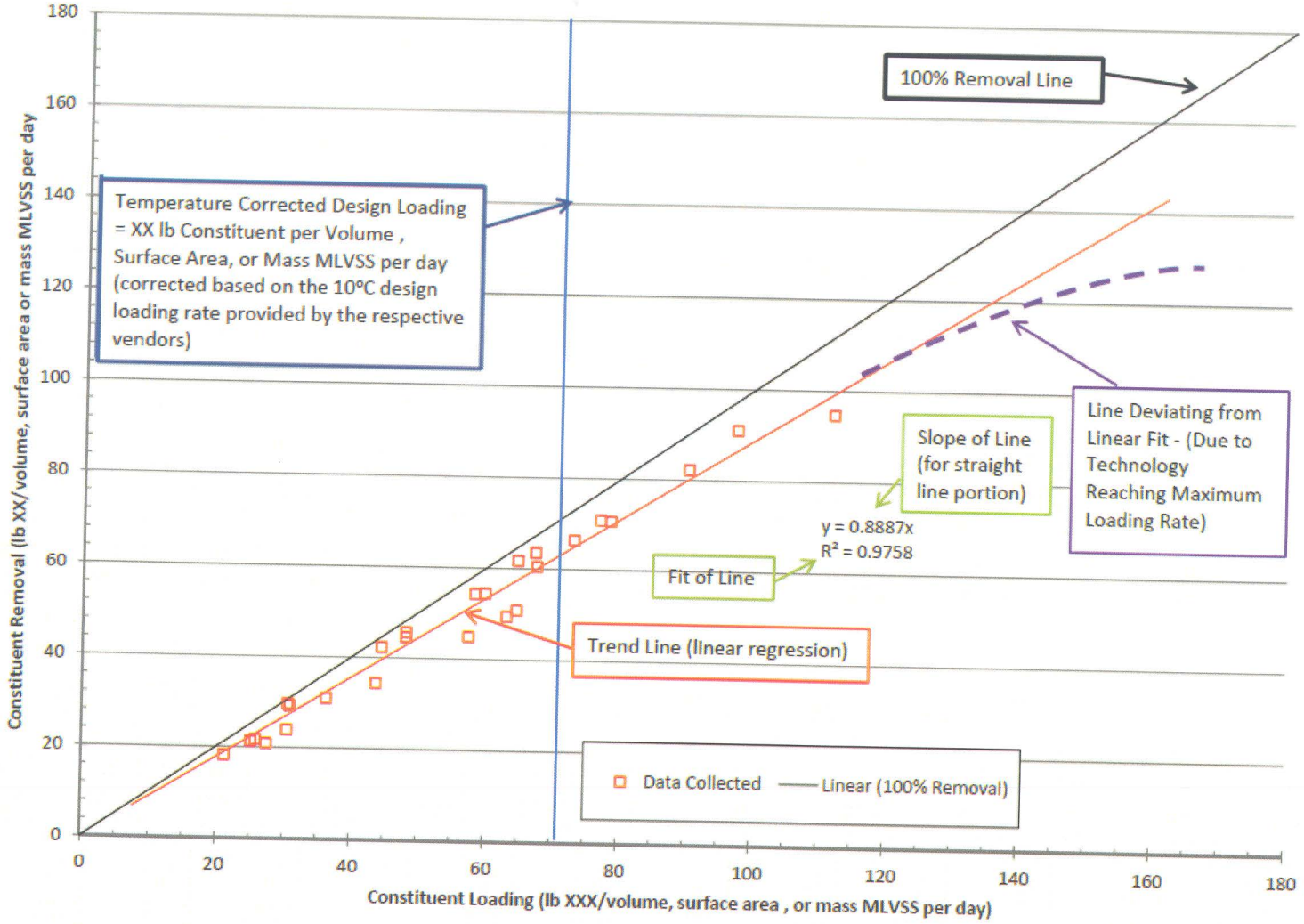
# Pilot Data Analysis



## Vendor Loading Rate Verification:

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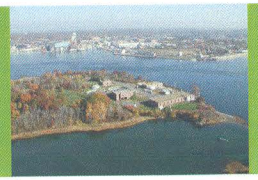
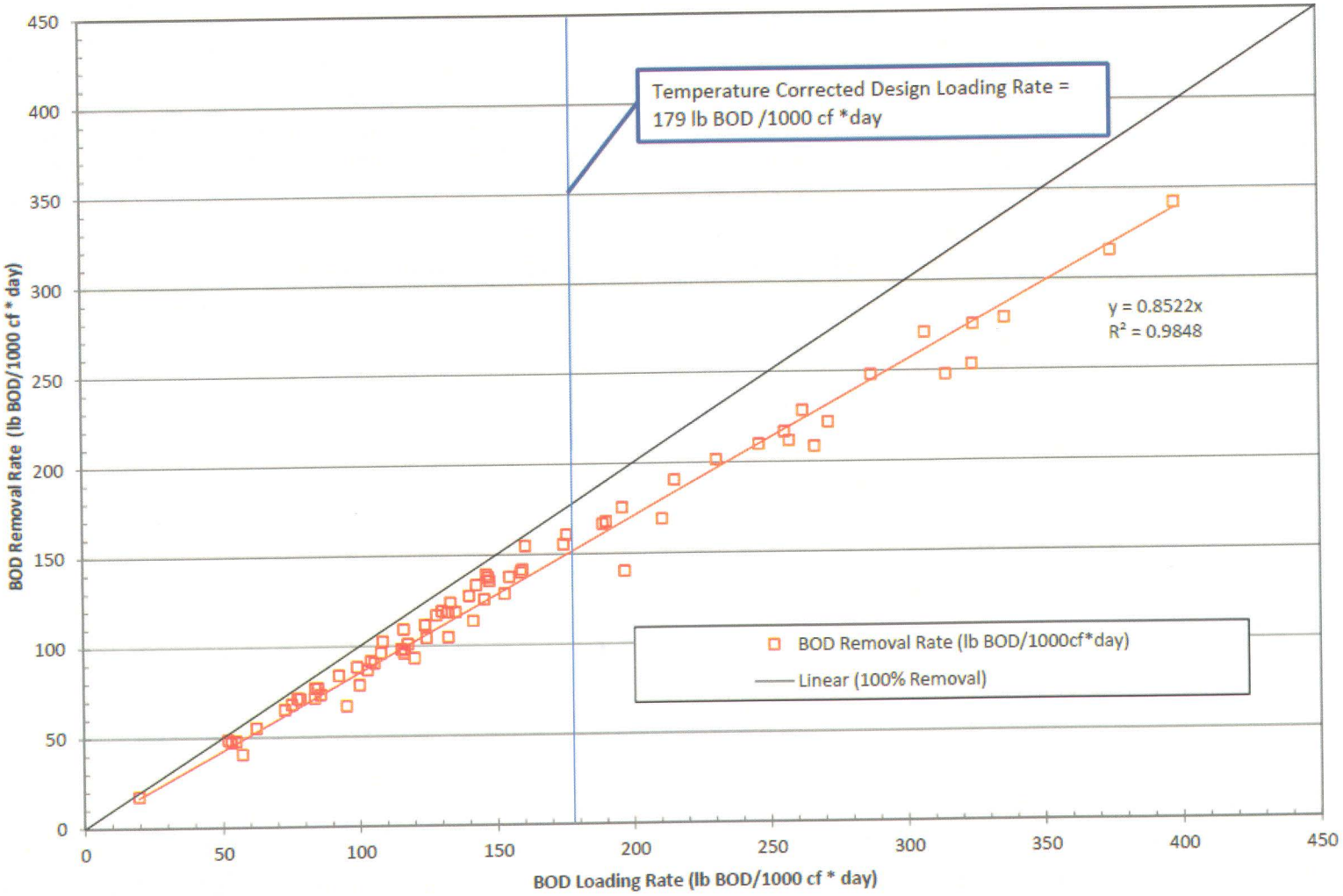
# Pilot Data Analysis



## Vendor Loading Rate Verification For BAF for BOD

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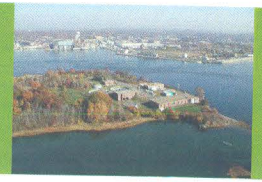
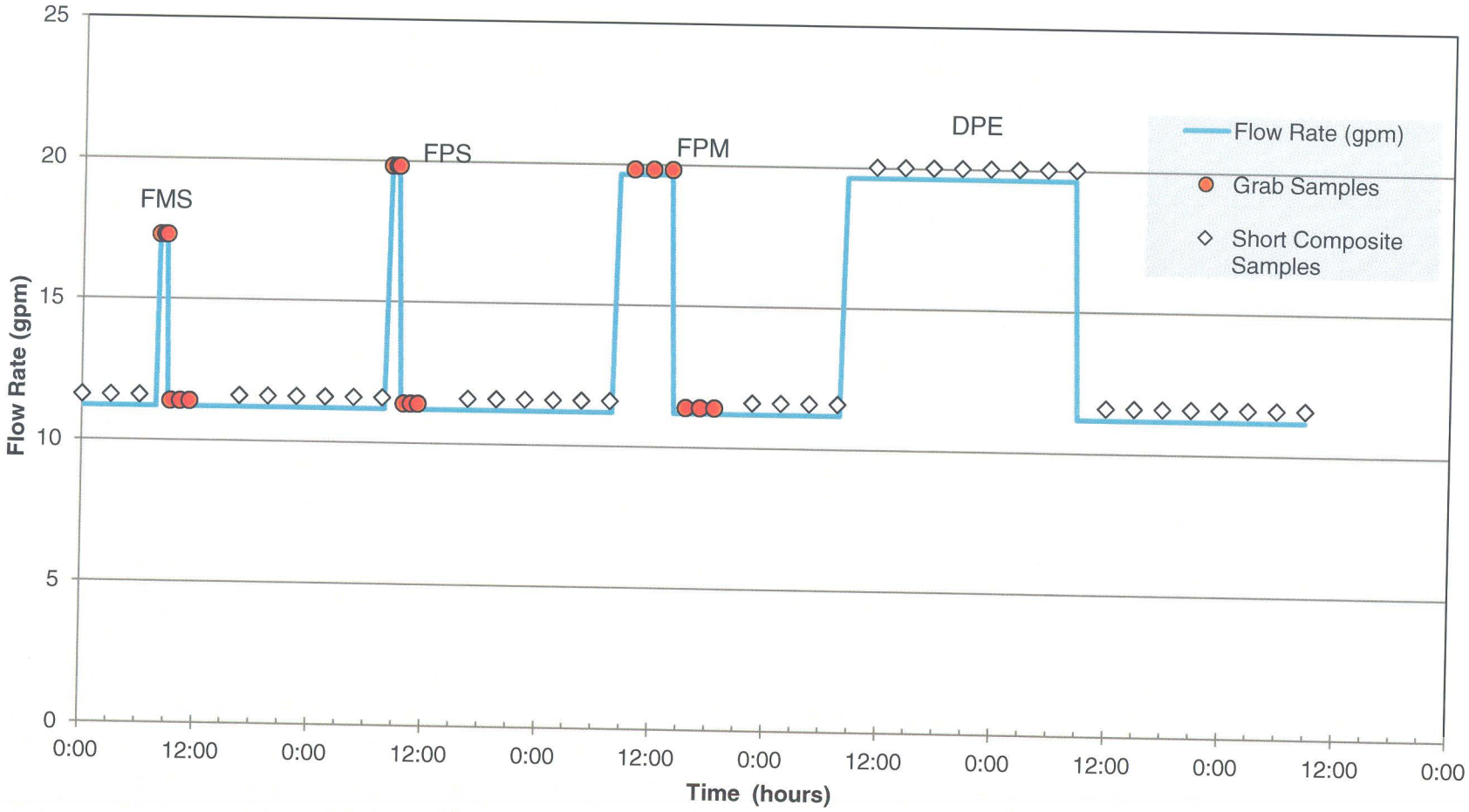
# Pilot Data Analysis



## Hydraulic Stress Test Performance Test Approach:

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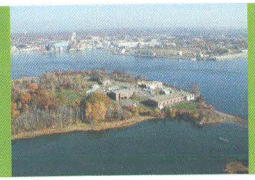
# Secondary Process Resizing and Comparison



## Approach:

- Resize Piloted Technologies with Revised Flows and Loads
- Provide Secondary Treatment with the Ability to Achieve Seasonal Average Effluent Total Nitrogen of 8 mg/l
- Prepare Layouts and Estimated Capital, O&M, and Life Cycle costs

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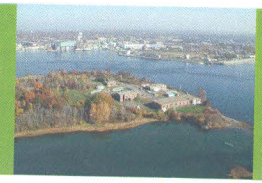
# Secondary Process Resizing and Comparison



Common Elements:

- Supplemental Alkalinity Storage and Feed
- Fine Screening and Secondary Influent Pumping
- Sludge Storage (CASB and MBBR only)
- Supplemental Carbon (BAF and MBBR only)
- Main Electrical Building and Standby Generator

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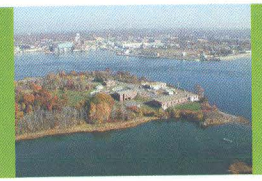
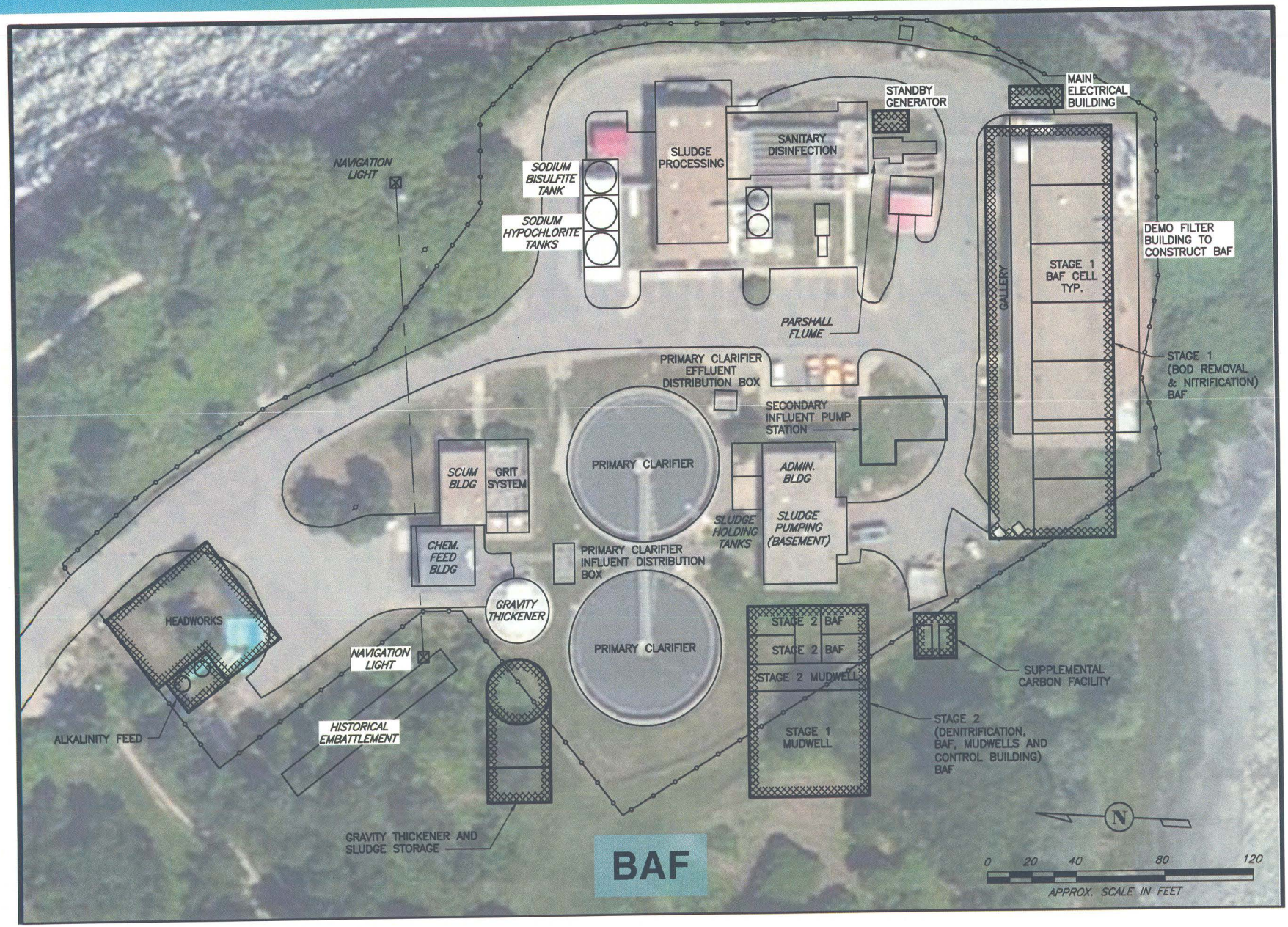
# Secondary Process Resizing and Comparison





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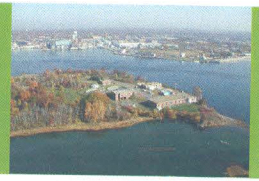

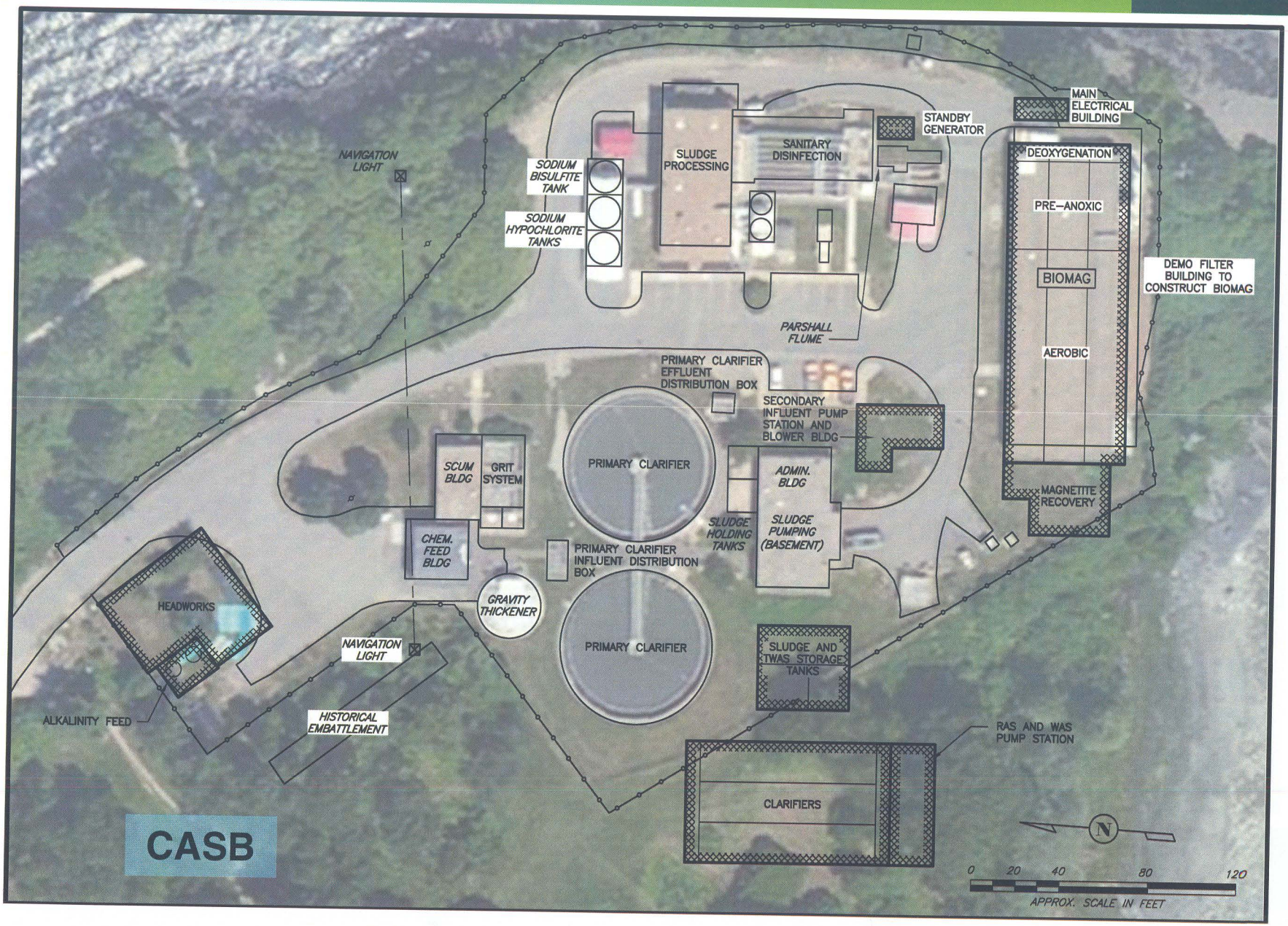

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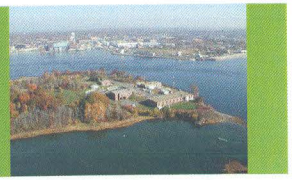

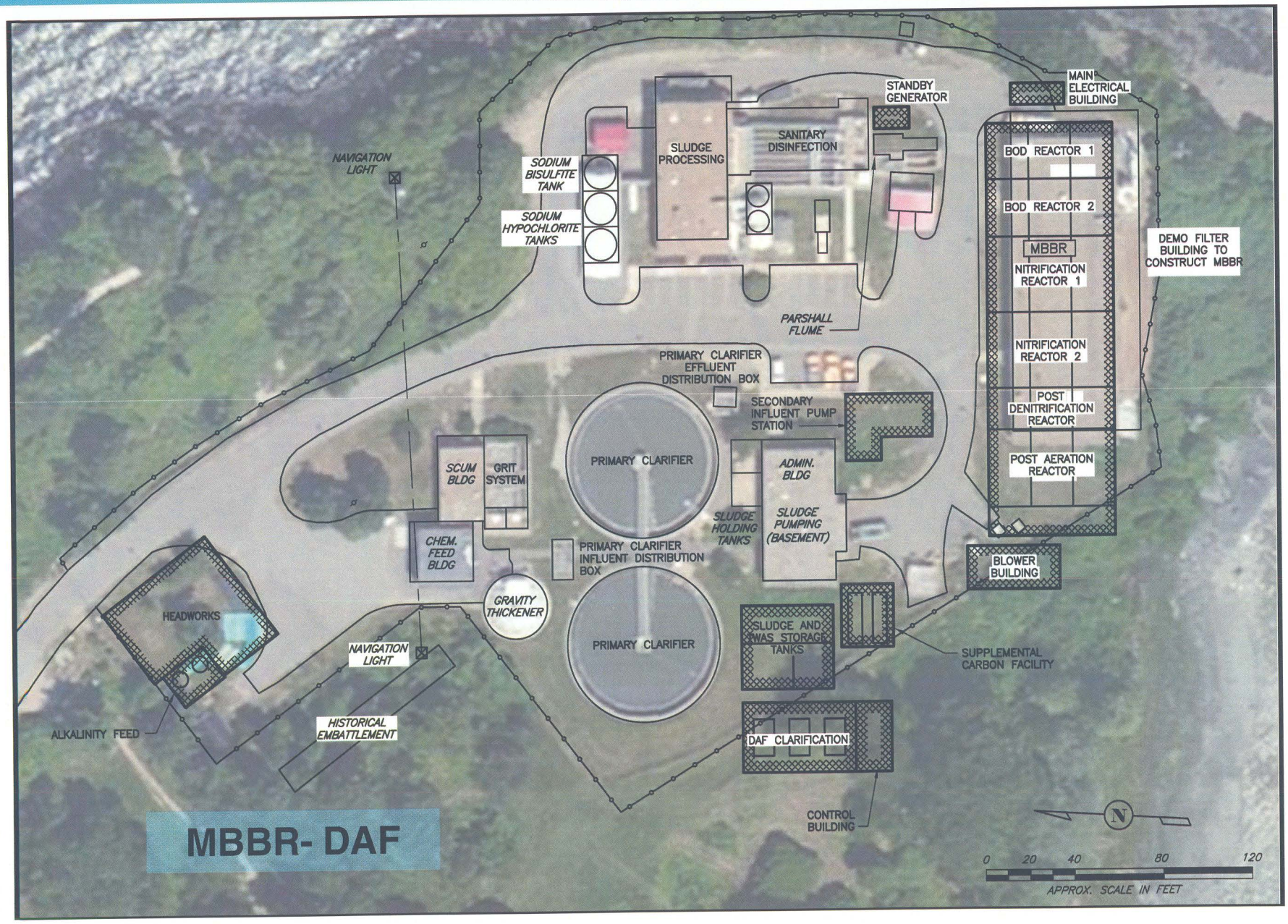

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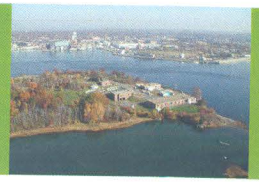

## Estimated 20 Year Life Cycle Costs

| Cost Item | BAF | CAS w/ BioMag | MBBR & DAF |
|---|---|---|---|
| Capital | $60.50 | $54.00 | $56.50 |
| 20 Year Present Worth O&M | $14.60 | $19.30 | $18.30 |
| 20 Year Life Cycle | $75.10 | $73.30 | $74.80 |

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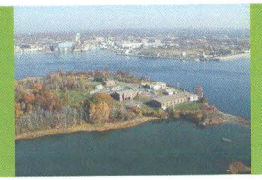
# Non-Monetary Evaluation Factors



- WWTF Operators Questionnaire
- Criteria Evaluation Matrix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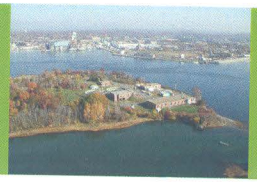
# Non-Monetary Evaluation Factors



## WWTF Operators Questionnaire

Covered 10 Areas:

1. Sampling & Analysis Requirements
2. Number & Complexity of Sub-Systems
3. Access for Troubleshooting Process
4. Appearance & Cleanliness
5. Maintenance Requirements
6. Ability To Automate System
7. Requirement for Online Analyzers
8. Health & Safety Issues
9. Requirement for Proprietary or Special Order Equipment, Materials, or Chemicals
10. Anticipated Level (Both Man-hours and Training) of Labor for Operation

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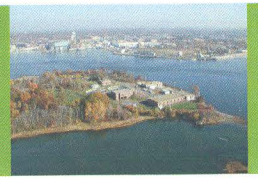
# Non-Monetary Evaluation Factors



## WWTF Operators Questionnaire

- 7 WWTF Operators Ranked All 10 Areas on a Score of 1(Least Desirable) to 5 (Most Advantageous)
- Results Averaged by Technology:

| Technology | Ranking |
|---|---|
| BAF | 3.1 |
| CASB | 1.9 |
| MBBR-DAF | 3.3 |

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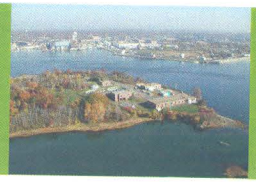
# Non-Monetary Evaluation Factors



## Criteria Evaluation Matrix

| | B | C | D | E | F | G | H | I | Evaluation Criteria | Score | Weighting Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | A 1 | C 3 | D 2 | A 1 | F 2 | G 2 | A 3 | A 1 | Operations Factors | 6 | 10 |
| **B** | C 3 | D 2 | E 1 | F 2 | G 2 | B 2 | I 1 | | Maintenance Factors | 2 | 3 |
| **C** | C 1 | C 2 | C 2 | C 2 | C 2 | C 2 | | | Health & Safety Factors | 17 | 27 |
| **D** | D 2 | D 1 | D 1 | D 2 | D 2 | | | | Operational Track Record/Established Process | 12 | 19 |
| **E** | F 2 | G 2 | E 1 | I 1 | | | | | Ability to Retrofit TN of 8 mg/l to Meet Future TN of 3 mg/l | 2 | 3 |
| **F** | G 1 | F 1 | F 1 | | | | | | Response to Sustained Wet Weather Flows | 8 | 13 |
| **G** | G 2 | G 2 | | | | | | | Response to Process Disruption | 11 | 18 |
| **H** | I 2 | | | | | | | | Potential for Technology Optimization | 0 | 0 |
| **I** | | | | | | | | | Ability to Exceed Treatment Performance Goals | 4 | 6 |
| | | | | | | | | | | Total | 100 |

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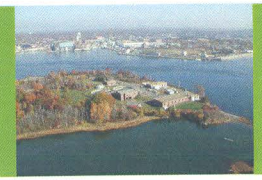
# Non-Monetary Evaluation Factors



## Option Evaluation Matrix

| Evaluation Criteria | Weight | BAF | | CAS w/ BioMag | | MBBR & DAF | |
|---|---|---|---|---|---|---|---|
| | | Rating | Score | Rating | Score | Rating | Score |
| Operations Factors | 10 | 3.0 | 30 | 2.1 | 21 | 3.2 | 32 |
| Maintenance Factors | 3 | 3.2 | 9.6 | 1.6 | 4.8 | 3.5 | 10.5 |
| Health & Safety Factors | 27 | 3.2 | 86.4 | 2.0 | 54 | 3.3 | 89.1 |
| Operational Track Record/Established Process | 19 | 4.0 | 76 | 2.0 | 38 | 3.0 | 57 |
| Ability to Retrofit TN of 8 mg/l to Meet Future TN of 3 mg/l | 3 | 5.0 | 15 | 2.5 | 7.5 | 3.0 | 9 |
| Response to Sustained Wet Weather Flows | 13 | 3.5 | 45.5 | 4.0 | 52 | 3.5 | 45.5 |
| Response to Process Disruption | 18 | 4.0 | 72 | 3.0 | 54 | 4.0 | 72 |
| Potential for Technology Optimization | 0 | 2.5 | | 2.5 | | 4.0 | |
| Ability to Exceed Treatment Performance Goals | 6 | 3.0 | 18 | 4.0 | 24 | 3.0 | 18 |
| Total Weighted Criteria | | 353 | | 255 | | 333 | |
| Capital Cost (estimated - in millions) | | $60.5 | | $54.0 | | $56.5 | |
| Value Ratio (criteria/capital cost) | | **5.8** | | **4.7** | | **5.9** | |
| Life Cycle Cost (in millions) | | $75.1 | | $73.3 | | $74.8 | |
| Value Ratio (criteria/ life cycle cost) | | **4.7** | | **3.5** | | **4.5** | |

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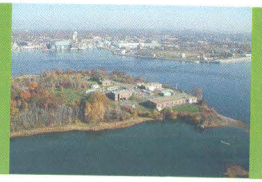
# Piloting Technical Memorandum



## Recommendations & Assumptions:

✓ Secondary Treatment Design Capacity

| Parameter | Annual Average Day | Max Month |
|---|---|---|
| Flow (mgd) | 6.13 | 8.86 |
| Influent TSS (mg/L) | 199 | 187 |
| Influent TSS (lb/d) | 10,176 | 13,853 |
| Influent $BOD_5$ (mg/L) | 195 | 161 |
| Influent $BOD_5$ (lb/d) | 9,959 | 11,881 |
| Influent TKN (mg/L) | 29.5 | 27.6 |
| Influent TKN (lb/d) | 1,511 | 2,039 |
| | | |
| Primary Effluent TSS (mg/L) | **99 - 147** | **94 - 138** |
| Primary Effluent TSS (lb/d) | **5,088 – 7,510** | **6,927 – 10,224** |
| Primary Effluent $BOD_5$ (mg/L) | **136 - 165** | **113 - 136** |
| Primary Effluent $BOD_5$ (lb/d) | **6,971 – 8,4357** | **8,317 – 10,063** |
| Primary Effluent TKN (mg/l) | **26.9 - 28.6** | **25.1 - 26.8** |
| Primary Effluent TKN (lb/d) | **1,375 – 1,465** | **1,856 – 1,978** |

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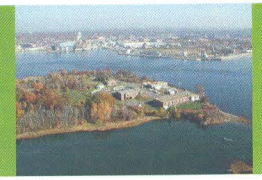
# Piloting Technical Memorandum



## Recommendations & Assumptions:

✓ BAF is the Recommended Process for Secondary Treatment with the Ability to Meet an Effluent Total Nitrogen of 8 mg/l based on:

- Secondary Treatment Facilities Sized to Treat the Revised Flows and Loads Presented in the Piloting Tech. Memo. and Meet the BOD and TSS Effluent Concentrations Contained in the 2007 NPDES Permit
- Seasonal Rolling Average (April – October) Effluent Nitrogen Limit of 8 mg/l
- Secondary and Total Nitrogen Limits Apply to the Effluent from the Secondary Treatment Process Prior to Combining with Wet Weather Flow
- Achieving 85 Percent Removal of TSS and BOD Through the Secondary Treatment Facilities only Required on Dry Weather Days

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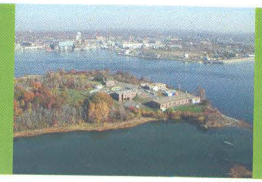
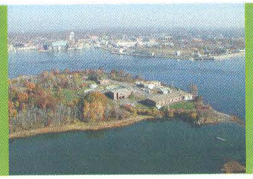


# Revised Secondary Treatment Flows and Loads

# Revised Flows and Loads



Topics For Discussion:

- Upgrade Concept
- Dry Day Definition
- Flow Data Set Parsing
- Existing Condition Flow Rates
- Existing Condition Volumetric Analysis
- Existing Condition Loading Analysis
- Future Condition Flow Rates
- Future Condition Volumetric Analysis
- Future Condition Loading Analysis

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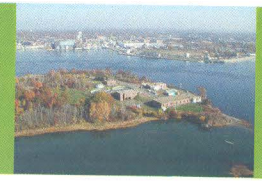
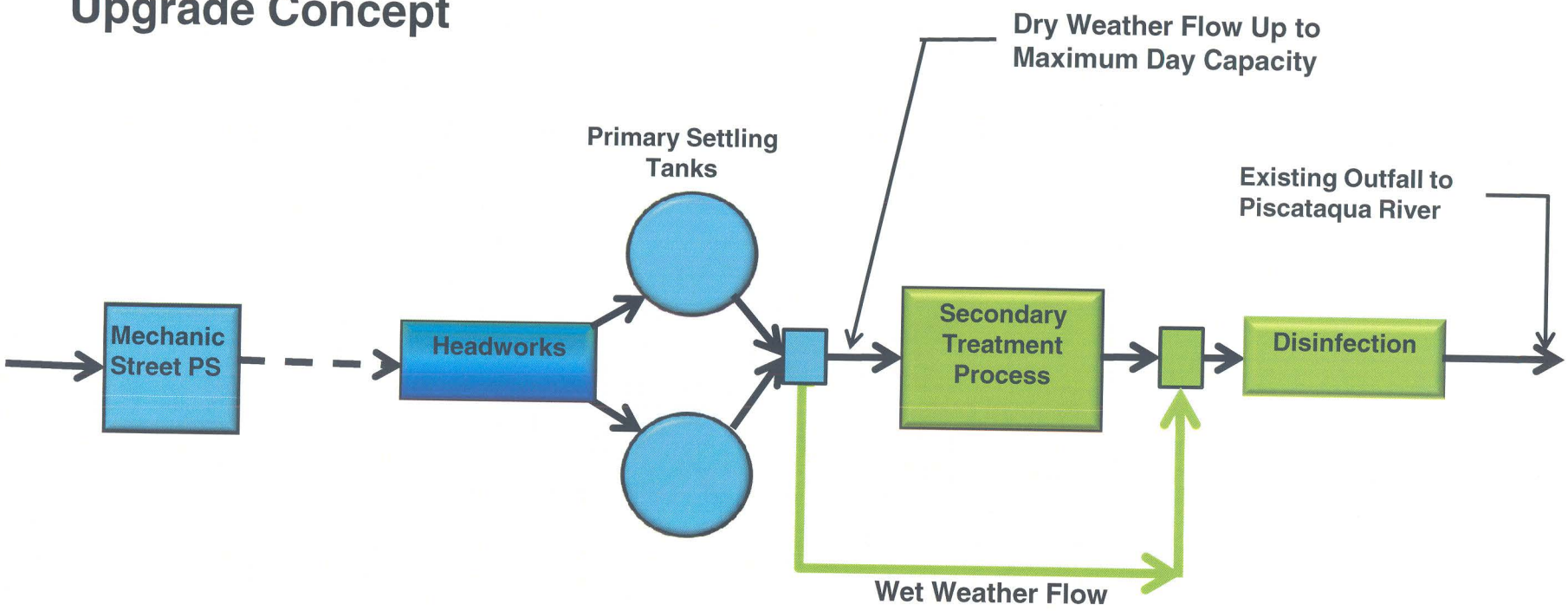
# Revised Flows and Loads



## Upgrade Concept

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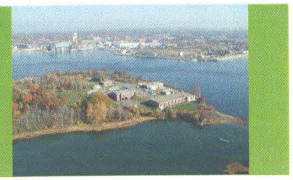
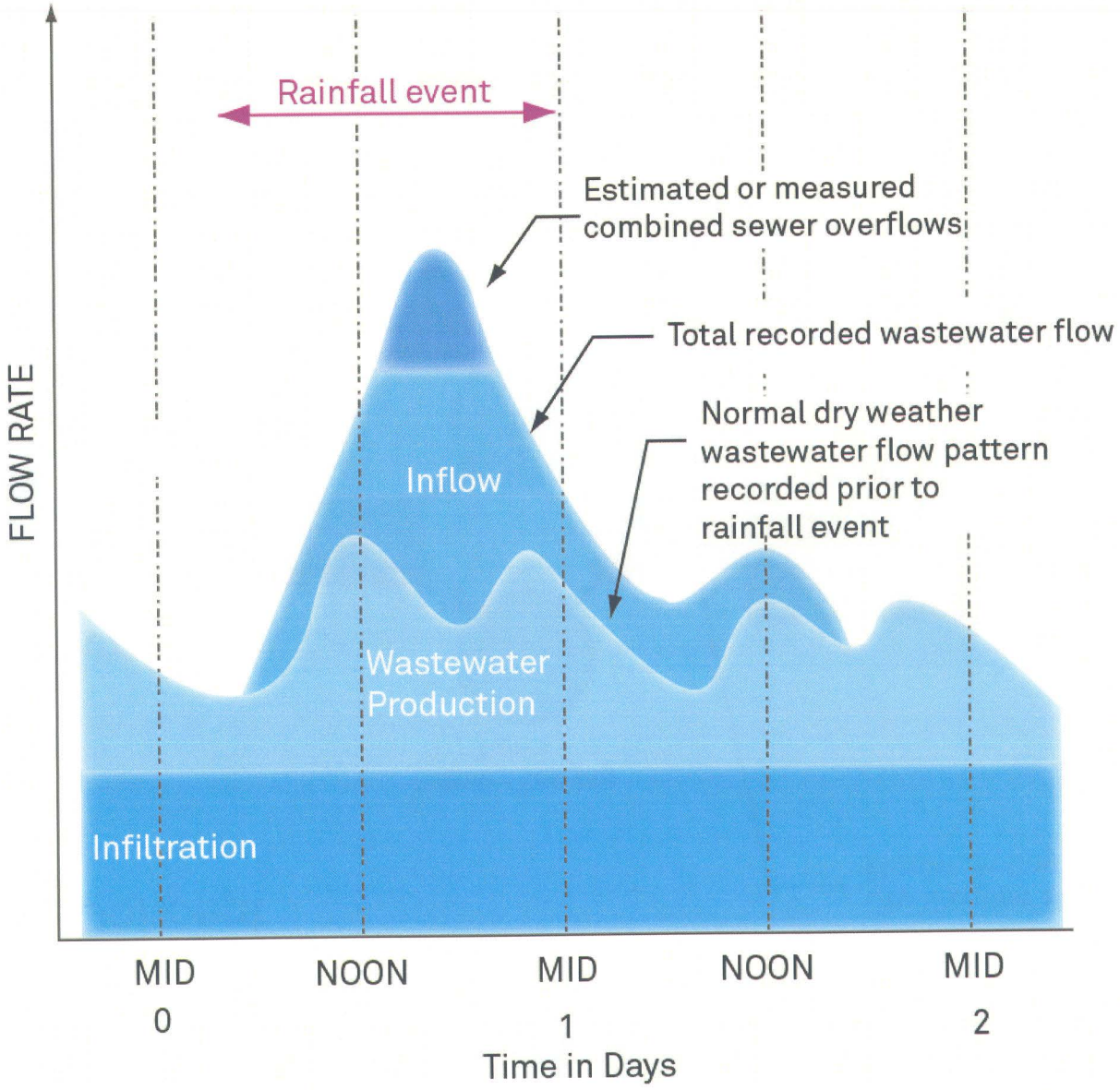
# Dry Day Definition



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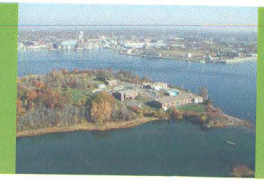
# Flow Data Set Parsing



- Reviewed 2008, 2009, 2010 Influent Flow, Precipitation, and Temperature Data
- Identified Selected Storm Events with Varying Total Precipitation and Duration
- Reviewed Continuous Flow Data for Selected Storm Events to Determine System Response Time for Flow to Recede to Pre-Storm Event flow Rate
- Precipitation Event Defined as Continuous or Intermittent Precipitation Not Separated by More Than 6 Hours

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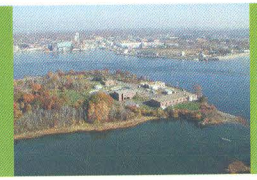
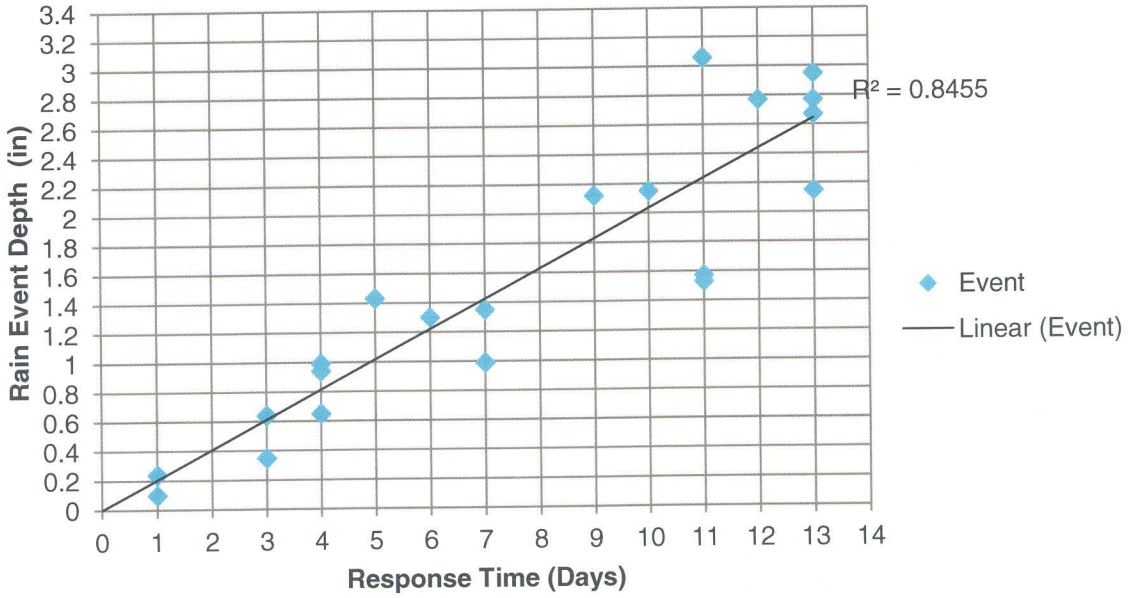
# Flow Data Set Parsing



## System Response To Precipitation

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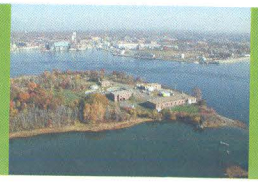
# Flow Data Set Parsing



## Wet Day Definitions

- Classify any day with precipitation greater than 0.05 inches as wet;
- Classify the next day following a precipitation day of 0.4 inches or greater as wet;
- Classify the next 2 days following a precipitation day of 0.6 inches or greater as wet;
- Classify the next 3 days following a precipitation day of 0.8 inches or greater as wet;
- Classify the next 4 days following a precipitation day of 1.0 inches or greater as wet;
- Classify the next 5 days following a precipitation day of 1.2 inches or greater as wet;
- Classify the next 6 days following a precipitation day of 1.4 inches or greater as wet;
- Classify the next 7 days following a precipitation day of 1.6 inches or greater as wet;
- Classify the next 8 days following a precipitation day of 1.8 inches or greater as wet;
- Classify the next 9 days following a precipitation day of 2.0 inches or greater as wet;
- Classify the next 10 days following a precipitation day of 2.2 inches or greater as wet;
- Classify the next 11 days following a precipitation day of 2.4 inches or greater as wet;
- Classify the next 12 days following a precipitation day of 2.6 inches or greater as wet;
- Classify any day with existing snow pack and temperature equal to or greater than 32 degrees F as wet;

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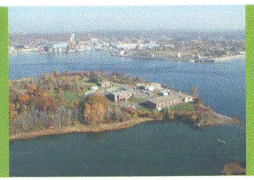
# Flow Data Set Parsing



- Apply Wet Day Definitions to WWTF Flow Data for January 1, 2008-June 30, 2012
- Parse Data into Wet and Dry Days
- Identify Highest Dry Day Flow in Dry Day Data Set = Maximum Daily Flow for Secondary Treatment (7.73 mgd)
- Compute Average Daily Flow using Dry Day Flows and Wet Day Flows Truncated at 7.73 mgd
- Compute Maximum Month Flow as 30 day Rolling Average of Average Daily Flow Data Set

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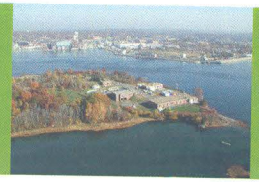
# Existing Condition Flow Rates



| Criteria | Flow (MGD) | Peaking Factor (to annual average day) |
|---|---|---|
| Parsed Dry Average Day | 4.34 | |
| Average Annual Flow | 5.23 | - |
| Maximum Month Flow | 7.56 | **1.44** |
| Maximum Day Dry Weather Flow | 7.73 | **1.48** |

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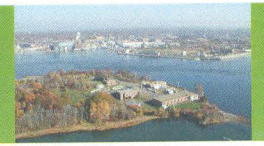
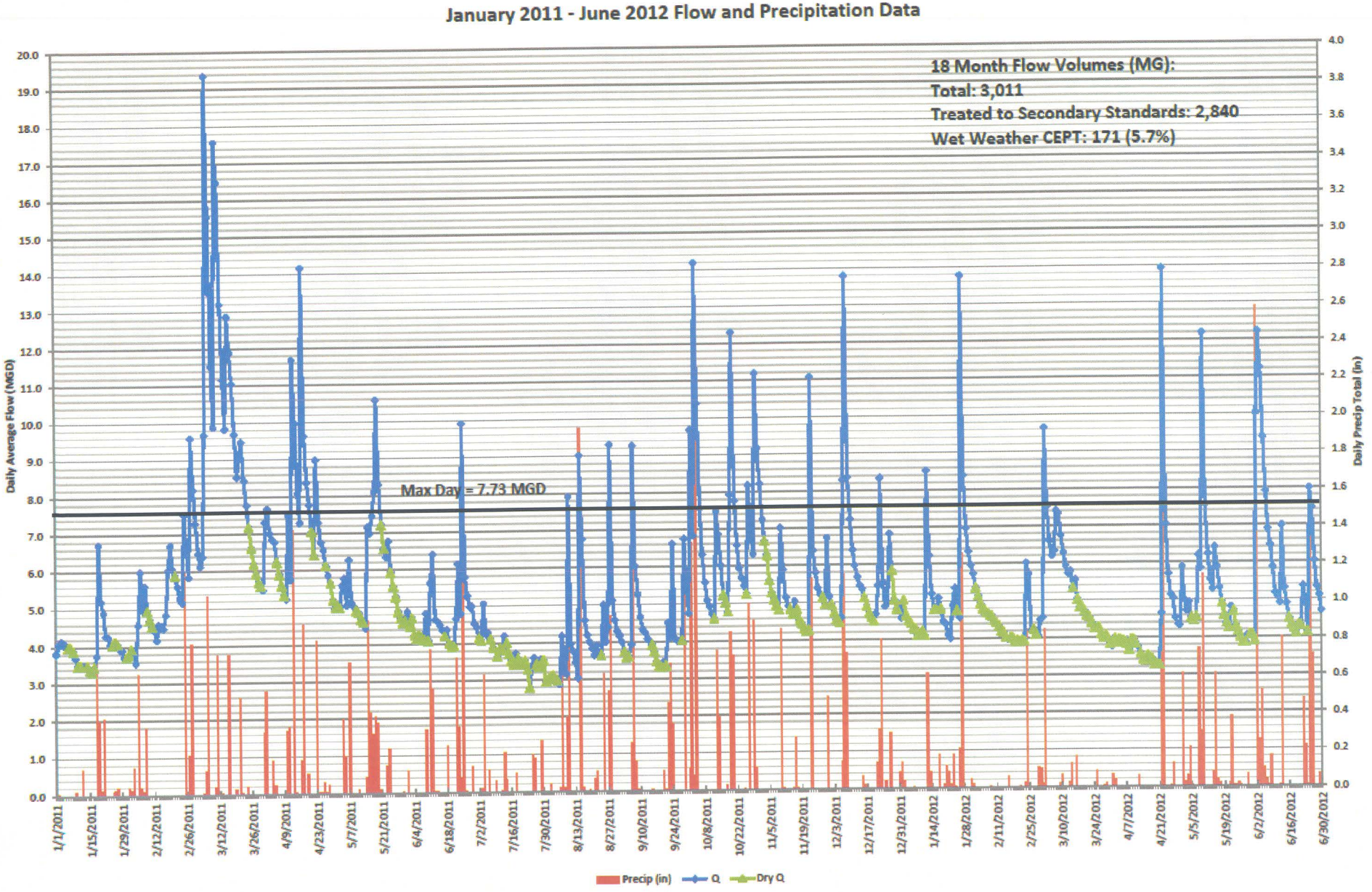
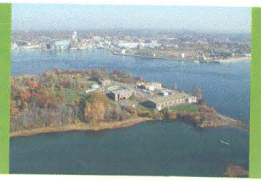
# Existing Condition Volumetric Analysis





# Existing Condition Volumetric Analysis



## Annual Flow Volumes with Max. Day Flow to Secondary of 7.73 MGD

| Year | Total Annual Flow (MG) | Treated to Secondary (MG) | Percent of Annual Flow | Wet Weather Flow (MG) | Percent of Annual Flow |
|---|---|---|---|---|---|
| 2008 | 2,187 | 2,000 | 91.5 | 187 | 8.5 |
| 2009 | 2,204 | 2,047 | 92.9 | 157 | 7.1 |
| 2010 | 1,938 | 1,713 | 88.4 | 225 | 11.6 |
| 2011- June 2012 | 3,011 | 2,840 | 94.3 | 171 | 5.7 |
| Total | 9,340 | 8,600 | 92.1 | 740 | 7.9 |
| | | | | | |

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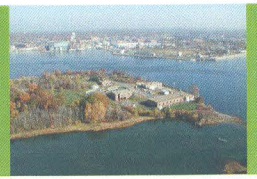
# Existing Condition Loading Analysis



- Initial Loading Projection Based on 2008-2010 Influent BOD and TSS Data

- During Conduct of the Piloting, Influent Concentrations Observed to be Higher than Projected

| Parameter | Initial Concentration Projection (mg/l) | Pilot Data Median Concentration (mg/l) |
|---|---|---|
| $BOD_5$ | 187 | 252 |
| TSS | 181 | 176 |

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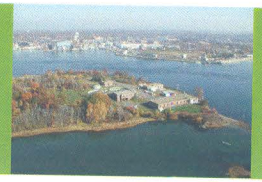
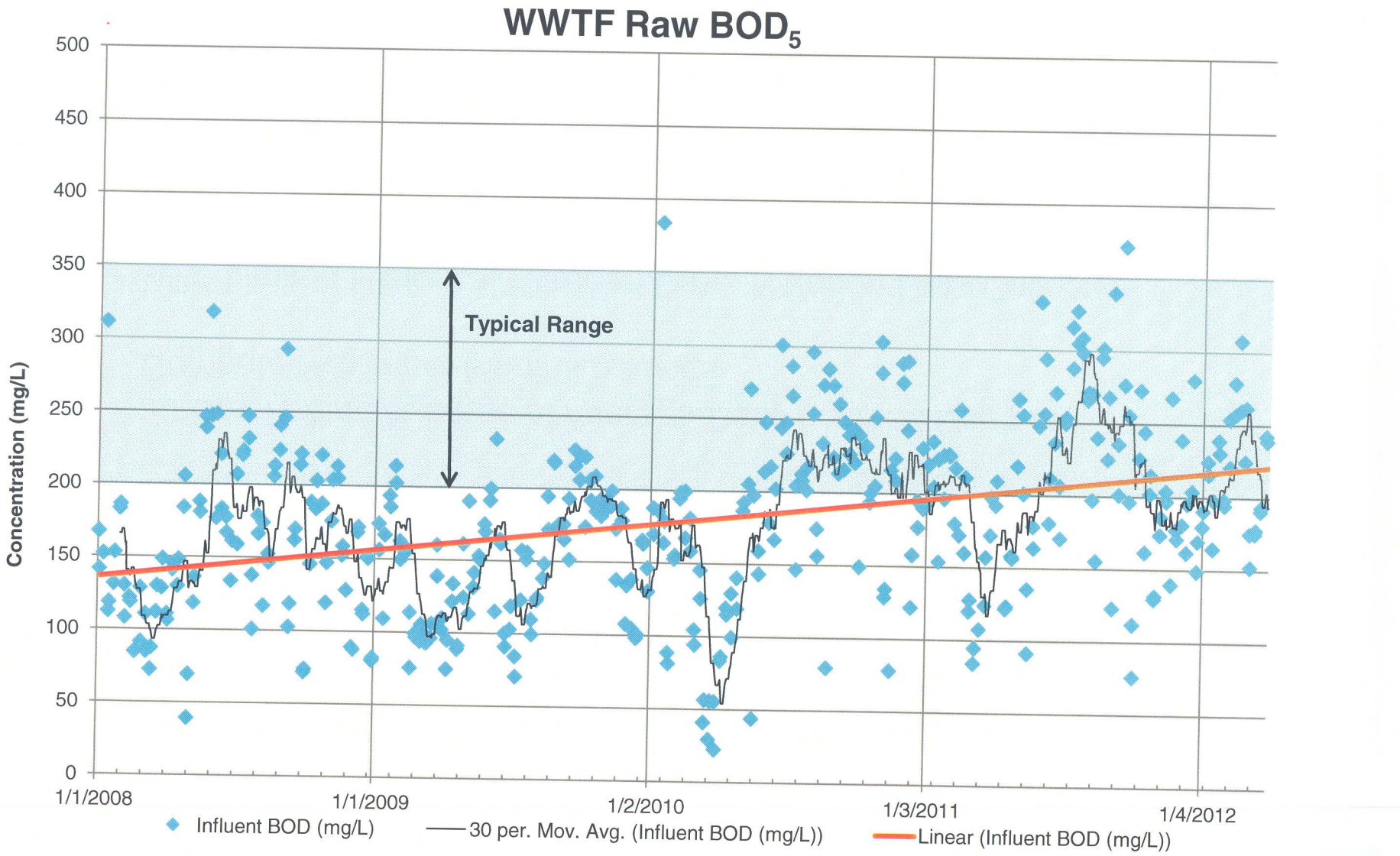
# Existing Condition Loading Analysis



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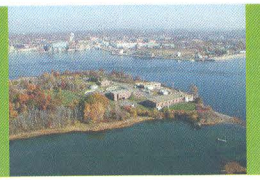
# Existing Condition Loading Analysis



- Based on Observed Trend in Loads, Revised Loading Analysis Completed Using Data from 2011-2012
- Truncated Flow Data Set for 2011-2012 (18 months) and Measured Influent BOD and TSS Concentrations Used to Compute Average Daily Loading.
- 30 Day Rolling Average of Average Daily Loading Used to Compute Maximum Month Loadings
- With Limited Historical Nitrogen Data, Nitrogen Data Collected During the Pilot Used to Establish Average TKN Loading with Peaking Factor to Compute Max. Month TKN Loading
- Removal Rates Through Primary and CEPT Applied to Establish Primary Effluent and CEPT Effluent Loads to Secondary.

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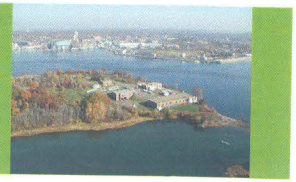
# Existing Condition Loading Analysis



| Parameter | Annual Average Day | Max Month PF | Removal Efficiency, % | Max Month |
|---|---|---|---|---|
| Flow (MGD) | 5.23 | **1.44** | | 7.56 |
| Influent TSS (mg/L) | **201** | | | **190** |
| Influent TSS (lb/d) | 8,792 | **1.36** | | 11,969 |
| Influent $BOD_5$ (mg/L) | **197** | | | **163** |
| Influent $BOD_5$ (lb/d) | 8,610 | **1.19** | | 10,271 |
| Influent TKN (mg/l) | 29.5 | | | **27.6** |
| Influent TKN (lb/d) | **1,289** | 1.35 | | **1,740** |
| | | | | |
| Primary Effluent TSS (mg/L) | **101 - 149** | | 26% - 50% | **95 - 140** |
| Primary Effluent TSS (lb/d) | **4,396 – 6,489** | | | **5,985 – 8,833** |
| Primary Effluent $BOD_5$ (mg/L) | **138 - 167** | | 15% - 30% | **114 - 138** |
| Primary Effluent $BOD_5$ (lb/d) | **6,027 - 7,292** | | | **7,190 -8,700** |
| Primary Effluent TKN (mg/l) | **26.9 - 28.6** | | 3% - 9% | **25.1 - 26.8** |
| Primary Effluent TKN (lb/d) | **1,173 - 1,250** | | | **1,584 - 1,688** |
| | | | | |
| CEPT Effluent TSS (mg/L) | **52** | | **74%** | **49** |
| CEPT Effluent TSS (lb/d) | 2,262 | | | 3,079 |
| CEPT Effluent $BOD_5$ (mg/L) | **122** | | **38%** | **101** |
| CEPT Effluent $BOD_5$ (lb/d) | 5,330 | | | 6,359 |
| CEPT Effluent TKN (mg/l) | **24.2** | | **18%** | **22.6** |
| CEPT Effluent TKN (lb/d) | **1,057** | | | **1,427** |

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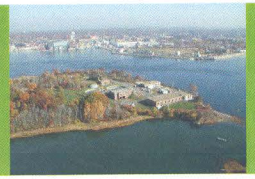
# Future Condition Flow Rates



- Added Allowance for Future Growth in the Next 20 Years to Existing Condition Flow Rates to Establish Future Flow Rates

| Criteria | 2012 Flow (MGD) | Peaking Factor (to average day) | Projected 20 Year Flow Increase (MGD) | 2032 Flow (MGD) |
|---|---|---|---|---|
| Secondary Treatment Average Annual Flow | 5.24 | | 0.9 | **6.13** |
| Secondary Treatment Maximum Month | 7.56 | 1.44 | 1.30 | **8.86** |
| Secondary Treatment Maximum Day | 7.73 | 1.48 | 1.33 | **9.06** |

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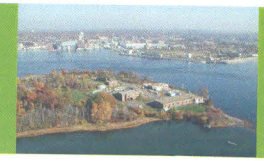
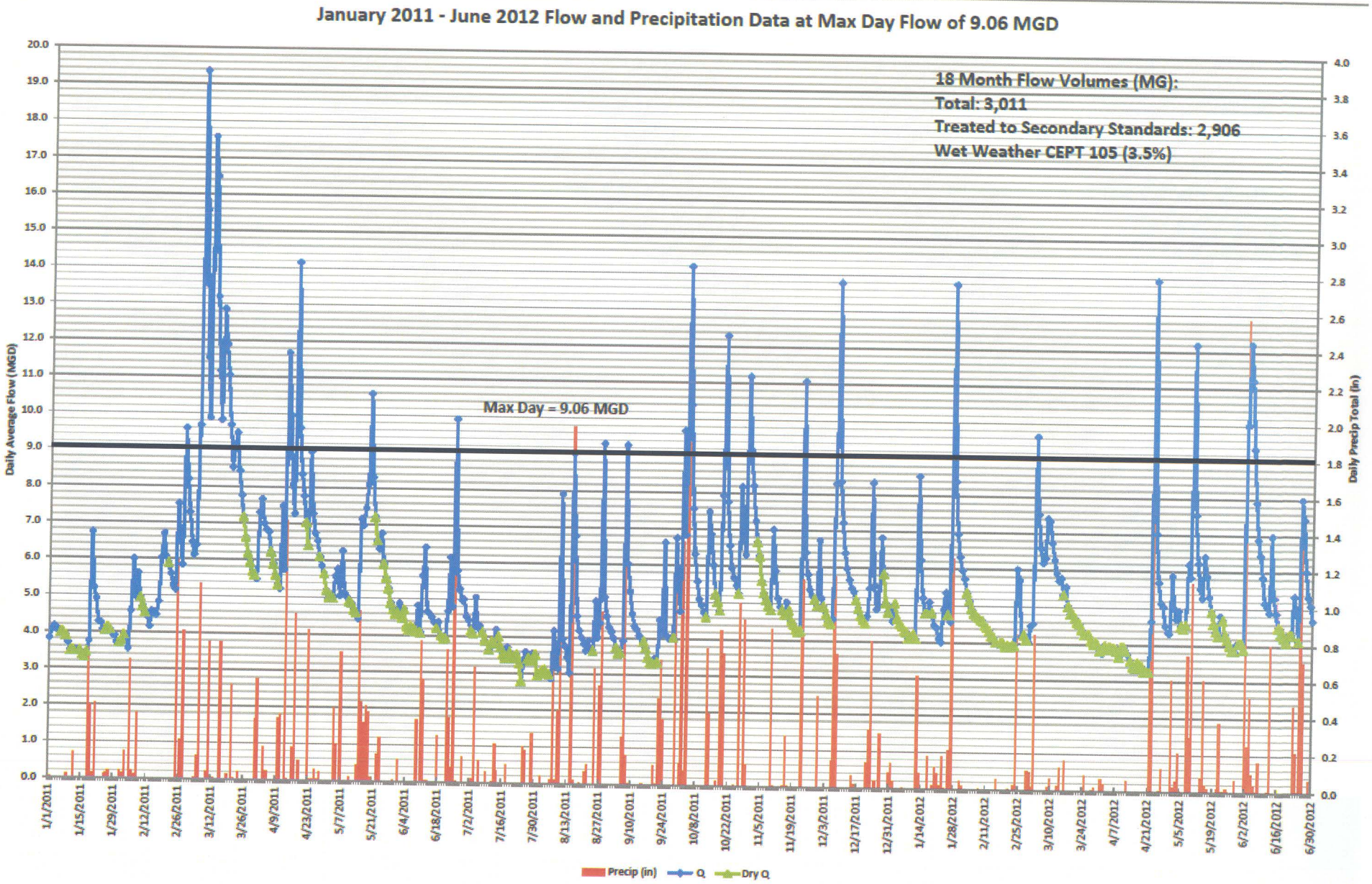
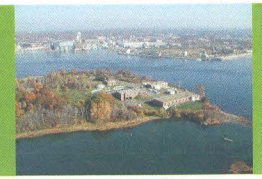
# Future Condition Volumetric Analysis





# Future Condition Volumetric Analysis



## Annual Flow Volumes with Max. Day Flow to Secondary of 9.06 MGD

| Year | Total Annual Flow (MG) | Treated to Secondary (MG) | Percent of Annual Flow | Wet Weather Flow (MG) | Percent of Annual Flow |
|---|---|---|---|---|---|
| 2008 | 2,187 | 2,068 | 94.6 | 119 | 5.4 |
| 2009 | 2,204 | 2,112 | 95.8 | 92 | 4.2 |
| 2010 | 1,938 | 1,766 | 91.1 | 172 | 8.9 |
| 2011- June 2012 | 3,011 | 2,906 | 96.5 | 105 | 3.5 |
| Total | 9,340 | 8,852 | 94.8 | 488 | 5.2 |
| | | | | | |

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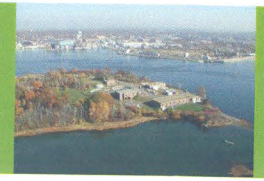
# Future Condition Loading Analysis



- Allowance for Loads from Future Growth Added to Existing Average BOD, TSS and TKN Loadings

- Maximum Month Loads Computed from Average Loads with Peaking Factors

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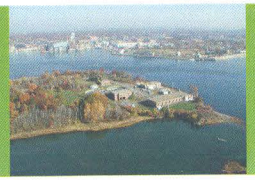
# Future Condition Loading Analysis



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| Flow (mgd) | 6.13 | 1.44 | | 8.86 |
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| Influent TSS (lb/d) | 10,176 | 1.36 | | 13,853 |
| Influent $BOD_5$ (mg/L) | 195 | | | 161 |
| Influent $BOD_5$ (lb/d) | 9,959 | 1.19 | | 11,881 |
| Influent TKN (mg/l) | 29.5 | | | 27.6 |
| Influent TKN (lb/d) | 1,511 | 1.35 | | 2,039 |
| | | | | |
| Primary Effluent TSS (mg/L) | **99 - 147** | | 26% - 50% | **94 - 138** |
| Primary Effluent TSS (lb/d) | **5,088 – 7,510** | | | **6,927 – 10,224** |
| Primary Effluent $BOD_5$ (mg/L) | **136 - 165** | | 15% - 30% | **113 - 136** |
| Primary Effluent $BOD_5$ (lb/d) | **6,971 – 8,4357** | | | **8,317 – 10,063** |
| Primary Effluent TKN (mg/l) | **26.9 - 28.6** | | 3% - 9% | **25.1 - 26.8** |
| Primary Effluent TKN (lb/d) | **1,375 – 1,465** | | | **1,856 – 1,978** |
| | | | | |
| CEPT Effluent TSS (mg/L) | **51** | | 74% | **48** |
| CEPT Effluent TSS (lb/d) | **2,618** | | | **3,564** |
| CEPT Effluent $BOD_5$ (mg/L) | **121** | | 38% | **100** |
| CEPT Effluent $BOD_5$ (lb/d) | **6,166** | | | **7,356** |
| CEPT Effluent TKN (mg/l) | **24.2** | | 18% | **22.6** |
| CEPT Effluent TKN (lb/d) | **1,239** | | | **1,672** |

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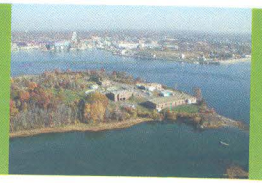
# Open Discussion



## Questions, Answers, and Discussion

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